PATENT SPECIFICATION 974,840

DRAWINGS ATTACHED.

974,840

Date of Application and filing Complete Specification :
June 13, 1962. *No. 22772/62.*

Application made in United States of America (No. 128,165) on July 31, 1961.

(Patent of Addition to No. 971,544, dated June 5, 1961).

Complete Specification Published : Nov. 11, 1964.

Index at Acceptance :—H1 X5.

International Classification :—H 01 j.

COMPLETE SPECIFICATION.

Static Discharger Apparatus.

We, GRANGER ASSOCIATES, a Corporation of the State of California, United States of America, of 974 Commercial Street, Palo Alto, California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The present invention relates to static dischargers and more particularly to static dischargers especially suitable for eliminating static interference in aircraft or the like.

This invention is an improvement in or modification of the invention claimed in Patent Application No. 20254/61 (Serial No. 971,544). These static dischargers, which have been very successfully employed in eliminating or substantially reducing the static problem in aircraft, operate on the principle that the region of highest d—c field near the charged up aircraft, which is the region at which corona discharge will occur from the moving aircraft, is caused to correspond to the region in which the radio frequency antenna field is near zero, or the region in which the two sets of field liners are at right angles, or preferably both. Corona discharges at such a near zero r—f field location will result in the minimum amount of static interference in the antenna. Such static dischargers are employed at the most effective locations on the aircraft, for example, the trailing edges and the tips of the wings and vertical and horizontal stabilisers, resulting in a reduction in corona threshold potential of the aircraft by a factor of from 6 to 15, forcing all corona to occur from the static dischargers rather than from locations on the aircraft which are coupled to the aircraft antennae. Due to these physical locations, the static dischargers are subjected to severe environmental conditions such as snow and rain, wind buffeting and vibrations. In addition, the dischargers extend out from the wing and stabiliser edges and are thus liable to be damaged during maintenance and the like. Under such conditions, the static dischargers must be strong enough to withstand the most severe environmental conditions and have long life, yet be lightweight, must retain their necessary electrical characteristics, and must be easily and economically fitted to and replaceable on existing and new aircraft.

It is, therefore, the principal object of the present invention to provide a lightweight, long life, easily replaceable static dicharger for use on objects subject to static interference due to corona discharges such as aircraft and under conditions of subsonic or supersonic flight.

According to the present invention there is provided a vehicle-mounted antenna in combination with a static discharger for reducing noise pick up in the antenna, the discharger being located at or near a region of minimum radio-frequency coupling field of the antenna to establish a discharge current in a direction substantially at right angles to the direction of residual radio-frequency coupling field of the antenna, wherein the discharger comprises a retainer base secured to the vehicle to be discharged, said base having a large surface area for physical and electrical contact with said vehicle, an elongated electrically non-conductive discharge member having a distributed high resistance electrically conductive coating thereon arranged to be removably secured to said retainer base at one end of said discharge member with said coating electrically coupled to said retainer base, and a metallic electrically conductive corona discharge pin

[*Price 4s. 6d.*]

secured in said discharge member with a sharp pointed end extending therefrom at a position spaced from said retainer base, said pin being electrically coupled to said resistive coating.

There is preferably provided an elongated retainer base cover having a cavity in one end wherein said elongated electrically non-conducting discharge member having a distributed high resistance electrically conductive coating thereon is fixedly secured, said retainer base cover being arranged at its other end for removably securing said cover to said base whereby an electrical path is completed from the vehicle through the base and cover to said resistive coating.

The invention will be described, by way of example with reference to the accompanying drawings wherein: —

Fig. 1 is a partial plan view of an airplane wing showing two groups of static dischargers according to the present invention secured thereto;

Fig. 2 is a plan view of one static discharger according to the present invention;

Fig. 3 is a view in side elevation of the discharger shown in Fig. 2;

Fig. 4 is a longitudinal cross-sectional view through a portion of the discharger taken along section line 4—4 in Fig. 2;

Fig. 4 (*a*) is a cross-sectional view of the discharger taken along section line 4(*a*)—4(*a*) in Fig. 2;

Fig. 5 is a plan view of another static discharger according to the present invention;

Fig. 6 is a view in elevation of the discharger of Fig. 5; and

Fig. 7 is a cross-sectional view of the discharger of Figs 5 and 6 taken along section line 7—7 of Fig. 5.

Referring now to Fig. 1 two groups of static dischargers, are disclosed for illustration purposes, one group 11 being suitable for mounting on the trailing edges of wings and stabilizers and the other group 12 on the tips or extremities thereof. It should be understood that the exact number and location of the static dischargers is determined by the constructions and configuration of the particular aircraft in accordance with the general principles set forth in the Specifications of United States Patent No. 2933732 and Patent Application No. 20254/61 (Serial No. 971,544). One discharger of the group 11 is shown in more detail in Figs. 2, 3 and 4 and comprises a retainer base 13 of strong, lightweight metal such as aluminium. This retainer base is plated, preferably with a nickel plating, to ensure corrosion resistance and to eliminate aluminium-to-aluminium contact, with the resultant formation of an aluminium oxide film, between the retainer base and the wing surface, thus providing high surface conductivity, i.e., low d—c resistance, between wing and base. The base 13 includes a wide relatively flat portion 13^1 and a narrow riser portion 13^{11}, the wide flat portion 13^1 serving as the mounting surface by which the discharger is secured, as by an electrically conducting adhesive, to the wing surface. The relatively large contact area between wing and retainer base ensures high electrical conductivity at this junction and large bonding area for highest shear strength. The edges of the base portion 13^1 are feathered slightly to distribute the stress, i.e., to prevent stress concentration at the edges of the base portion 13^1. The wide surface also permits the static discharger to be fastened to the wing by rivets if desired.

The riser portion 13^{11} of the base 13 has a rounded front edge 14 to reduce wind drag and a portion 15 of reduced cross-section which serves as a mount and support pedestal for a nickel plated aluminium retainer cover 16. The base riser 13^{11} is provided with a slanted slot into which a forward wall 18 of the cover 16 nestles and also a small recess into which the inner end of a set screw 19 fits. The cover 16 is so shaped as to fit snugly over the base portion 15, the set screw 19 serving to pull the wall 18 securely into the slanted slot and the cover 16 down on to the base. The slight incline of the slot results in an increase in the gripping force of the cover 16 on the base 13 with increase in wind drag. The particular shape of the cover 16, i.e., narrow and high with rounded, streamlined forward contour, and flush surface mounting on the retainer base 13 ensures small weight and wind-drag surface and yet substantial strength and also sufficient surface contact area between the base 13 and the cover 16 to ensure sufficient electrical conductivity to handle the maximum current flow occurring, for example, in lighting discharges from the aircraft, without welding 13 and 16 together.

A narrow elongated, strong, lightweight plastic member 21 made of, for example, Nylon, is secured by a screw 22 within an elongated cavity in the outer end of the retainer cover 16, this member 21 being arranged to extend out beyond the wing edge as shown in Fig. 1. The static discharge member 21, which itself is not electrically conductive, is coated with a high resistance paint, such as an epoxy base containing lamp-black and graphite. The coating extends over the surface of member 21 within the hollow cover 16 and, because the member fits snugly within the cover 16, a large conductive surface junction is formed between the coated member 21 and the cover 16. The substantial extent to which the coated member 21 extends within the cover 16 and the fact that the member 21 and cavity are taper-fitted provides a strong

and rigid support for the member 21 as well as a good electrical conducting junction. To ensure that the resistive coating on the member 21 is not cut or broken along the surface of the member, the surfaces of the member 21 and the cavity in the end of the cover are rounded off to eliminate any sharp edges.

A corona discharge pin 23 of conducting metal, such as tungsten, with very sharp pointed ends is embedded in the member 21, the pointed ends extending above and below the upper and lower edges or surfaces of the member. Small reservoirs or countersunk arcs 24 are located in the surface of the discharge member 21 where the pin 23 protrudes from the member, these reservoirs being filled with a solidified pool of good conducting metal, such as silver, to provide a good electrical conducting path between the resistive coating and the pin 23. The outer end of the discharge member 21 is capped with a plastic cover 25 to prevent corona discharges from the end.

It should be noted that the static discharger is so mounted on the wing (see Fig. 1) that the retainer base 13 is secured to the wing surface at the wing edge and the retainer cover 16 extends out over the edge of the wing to ensure that the d—c corona threshold potential is lower at the outer end of cover 16 than at the wing edge, so that lightning discharges will occur at the static discharger. The fact that the cover 16 extends out beyond the wing tends to confine lightning damage to the extending cover and thus prevent such damage from extending to the adjacent trailing edge of the metal wing.

The pin 23 is located in the elongated discharge member 21 at a distance from the base 13 such that the pin is located at a region of lowest r—f antenna field. The resistance-coated discharge member provides a region of high d—c field at the pin location, corona discharge occurring from the pin points and thus occurring in regions of near zero r—f antenna fields and at right angles to any residual r—f field lines. A more detailed explanation of the basic principles involved in such zero r—f field static dischargers may be found in the Specifications of the above cited Patent and Patent Application

It should be noted that only the retainer base 13 is secured to the airplane wing in a permanent fashion and that the base is relatively flat, hugging the wing surface, and does not extend out over the edge of the wing. For this reason, the base is relatively protected from physical injury and thus has a long life, especially since it is coated to prevent corrosion. The retainer cover 16 which carries the resistance-coated discharge member 21 does extend out over the wing edge and is therefore more subject to being struck and damaged, however the cover 16 is attached to the base 13 by a single set screw 19 which is positioned for easy access to an airplane maintenance man and thus the cover 16 and discharge member 21 may be easily and rapidly replaced on the wing if damaged.

The embodiment of the invention shown in Figs. 5, 6 and 7 is adapted to be mounted on the tips of the wings or stabilizers as shown by the group 12 in Fig. 1. The resistance-coated plastic discharge member 26 is narrow to reduce wind drag yet has a relatively large cross-sectional area for strength and rigidity and a large conducting surface area. The metal corona discharge pin 27 is surrouned by conducting metal reservoirs 28 at the surfaces of the discharge member 26. The discharge member 26 is secured within a nickel-plated aluminium retainer base 29 by means of a single set screw 31. The base 29 has a large undersurface arranged for securing the base to the wing tip as by cementing with electrically conductive adhesive. The plastic tip cover 32 prevents corona discharge from the end of the member 26. As with the discharger shown in Figs. 2 to 4, the discharge member 26 is easily replaceable in the base 29 by means of the set screw 31.

WHAT WE CLAIM IS:—

1. A vehicle-mounted antenna in combination with a static discharger for reducing noise pick up in the antenna, the discharger being located at or near a region of minimum radio-frequency coupling field of the antenna to establish a discharge current in a direction substantially at right angles to the direction of the residual radio-frequency coupling field of the antenna, wherein the discharger comprises a retainer base secured to the vehicle to be discharged, said base having a large surface area for physical and electrical contact with said vehicle, an elongated electrically non-conductive discharge member having a distributed high resistance electrically conductive coating thereon arranged to be removable secured to said retainer base at one end of said discharge member with said coating electrically coupled to said retainer base, and a metallic electrically conductive corona discharge pin secured in said discharge member with a sharp pointed end extending therefrom at a position spaced from said retainer base, said pin being electrically coupled to said resistive coating.

2. A combination according to Claim 1 comprising an elongated retainer base cover having a cavity in one end wherein said elongated electrically non-conducting discharge member having a distributed high resistance electrically conductive coating thereon is fixedly secured, said retainer base

cover being ararnged at its other end for removably securing said cover to said base whereby an electrical path is completed from the vehicle through the base and cover to said resistive coating.

3. A combination as claimed in Claim 1 or 2, wherein said coated discharge member is provided with a reservoir at the place where said pin extends from the discharge member, a solidified pool of electrically conductive material being positioned in said reservoir to provide a good electrically conductive path between said coating and said pin.

4. A combination as claimed in Claim 1, 2, or 3 including an electrically non-conductive cap covering the free end of said discharge member.

5. A combination as claimed in any of Claims 1 to 4, wherein said retainer base is made of nickel-plated aluminium.

6. A combination as claimed in any of Claims 1 to 5, wherein said high resistance electrically conductive coating is an epoxy base paint containing lamp-black and graphite.

7. A combination as claimed in Claim 3 or any claim dependent upon Claim 3, wherein said reservoir material is silver.

8. A combination as claimed in Claim 2 or any claim dependent upon Claim 2, wherein said elongated retainer base cover is secured to said retainer base at one end, the other end extending out from said base in such a manner that said cover absorbs lightning discharges before such discharges can reach the object on which said base is secured.

9. A vehicle-mounted antenna in combination with a static discharger substantially as hereinbefore described with reference to Figs. 1 to 4 or Figs. 1 and 5 to 7 of the accompanying drawings.

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Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1964.
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2,
from which copies may be obtained.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1

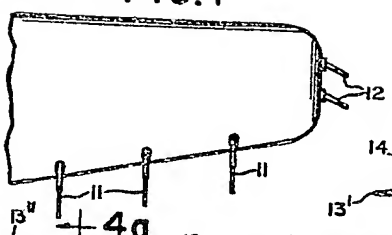


FIG. 4a

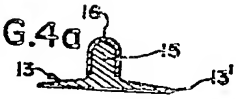


FIG. 4

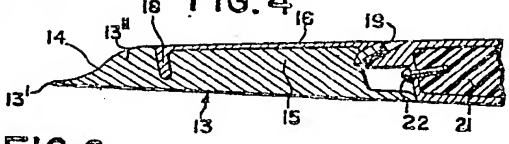


FIG. 2

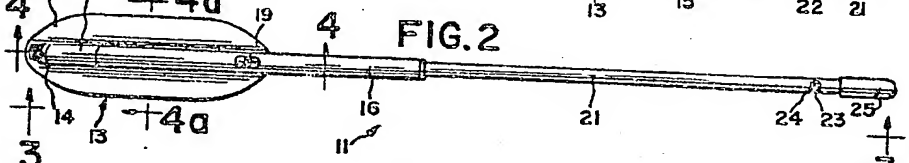


FIG. 3

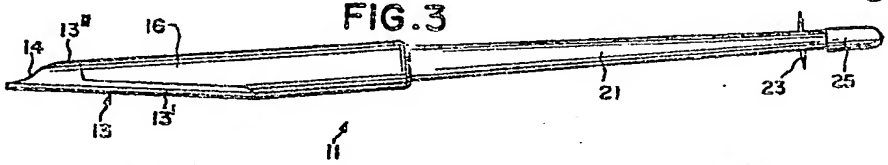
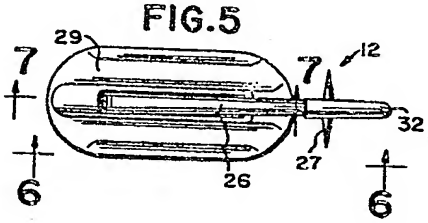


FIG. 5



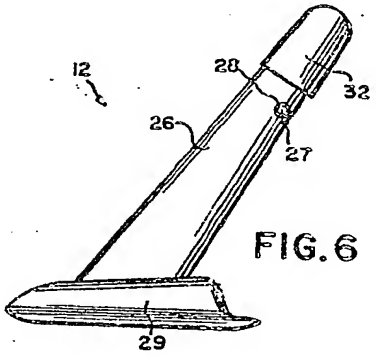


FIG. 6

FIG. 7